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BAROMETRIC CYCLES

ABOUT twelve years ago Mr. Baxendell of Manchester gave evidence of a connection between the convection-currents of the earth and the state of the sun's surface, and the subject has since been much discussed by meteorologists from various points of view.

Amongst these Mr. Meldrum of the Mauritius Observatory has brought forward much evidence in favour of a connection between sun-spots on the one hand and rainfall and cyclones on the other. Still more recently the Indian meteorologists, including the names of Messrs. Archibald, Blanford, Broun, Charles and Frederick Chambers, Eliot, and Hill have studied with much success the abnormal variations of barometric pressure in the tropics. Of these the researches of Mr. F. Chambers are particularly interesting¹ as exhibiting a very close relation between such barometric fluctuations and the state of the sun's surface.

The chief principle underlying these investigations is sufficiently obvious. We know that the marked differences in barometric pressure which exist between various portions of the earth's surface must be due to the sun; if therefore the sun be in reality variable we should naturally expect these differences to vary likewise in such a way as to be strengthened when the sun is most powerful and weakened when he has least influence. In accordance with this way of regarding things, Mr. Chambers in 1876 pointed out that the abnormal variations of the monthly mean barometric pressure at Bombay in that year were mainly variations in the intensity of the usual seasonal movements, while in 1877 he attributed the uniformly high barometric pressure and the deficient rainfall of that year to a weak development of the equatorial belt of minimum pressure, probably induced by a diminution of the solar heat.

In a diagram attached to his first communication Mr. Chambers compares the curve of solar-spotted area with other curves denoting the barometric pressure at various widely-distributed tropical stations, from which we can clearly see that there is a very marked resemblance between the salient points of the various curves on the hypothesis that a large amount of sun-spots corresponds to a low barometer. But besides this it appears that the epochs of maximum and minimum barometric pressure lag considerably behind the corresponding epochs of minimum and maximum solar-spotted area, and that this lagging behind is greater for easterly than for westerly stations, or in other words the abnormal barometric variations in the tropics may be said to travel at a very slow rate round the earth from west to east.

Perhaps the subject of greatest practical importance in these communications is the discussion regarding Indian famines and their connection with sun-spot minima—a connection first brought to light by Dr. Hunter. Mr. Chambers sums up his conclusions on this point as follows:—

1. Variations of the solar-spotted area are succeeded months afterwards by corresponding abnormal barometric

variations, a high barometer corresponding to a minimum of sun-spots.

2. Famines follow in the wake of curves of high barometric pressure.

Finally two methods are indicated by which early intimation of the approach of those meteorological disturbances which are attended by famines may possibly be obtained.

1. By regular observation of the solar-spotted area, and early reduction of the observations, so as to obtain early information of current changes going on in the sun.

2. By barometric observations at stations differing widely in longitude and the early communication of the results of stations situated to the westward.

While it thus appears that the evidence in favour of a connection between the state of the sun's surface and the meteorology of the earth is continually accumulating it may not be amiss to review briefly the present position of the problem.

In the first place Mr. Meldrum, as already mentioned, has given evidence that in numerous stations the rainfall is greater about times of maximum than about times of minimum sun-spot frequency.

Secondly. Through his labours and those of M. Pöey we have reason to believe that there are more cyclones in the Indian Ocean and hurricanes near the West Indies during times of maximum than during times of minimum sun-spot frequency.

Thirdly. There is the connection between the barometric fluctuations of the tropics and the state of the sun's surface which has just been pointed out.

Fourthly. From investigations in which I have been recently engaged there is reason to suppose that sun-spot inequalities of short duration are followed by corresponding inequalities in the diurnal temperature range of Toronto in such a way that a large amount of sun-spots slightly precedes a large temperature range.

Fifthly. To go from meteorology to magnetism there is the well known connection first observed by Sabine, in virtue of which the diurnal oscillations of the magnet are greatest about times of maximum sun-spots. And I may add that magnetic maxima lag behind sun-spot maxima, while there are also indications that magnetic weather, like meteorological weather, travels from west to east.

We thus perceive how strong the evidence is in favour of some connection between the state of the sun's surface and terrestrial meteorology, while at the same time it is unmistakably indicated by all elements that this connection is of such a nature as to imply that the sun is most powerful when there are most spots on his surface. Add to this that the spectroscopic observations of Lockyer and others tend in the same direction, as well as such actinometric results as we have been able to procure, chiefly through the labours of Mr. J. H. Hennessey at Dehra Dhoon and Mussoorie.

In fine this hypothesis is rapidly emerging, if indeed it has not already emerged, from the regions of mere conjecture.

But here it is necessary to bear in mind the following considerations. Prof. Stokes has pointed out that the problem before us really involves two questions, which may be stated as follows:—Firstly, do the changes which take place in the sun's surface correspond to changes in

¹ See NATURE, November 25 and December 2, 1880.

the meteorology and magnetism of the earth, and if so, does an increase of spotted area denote an increase of solar activity, or the reverse?

This question, I have already remarked, seems to be rapidly emerging from the realms of mere conjecture. But there is still another question, for we have to inquire whether these recognised solar inequalities bear all or any of the marks of a true periodicity. Now this is still *sub judice*, while at the same time it is a point of very great practical importance. For if the solar inequalities be found on investigation to present none of the marks of a true periodicity, we can hardly hope ever to be able to hazard a prediction regarding the state of the sun, and our knowledge of the eleven-yearly period, as it is called, will continue to remain very much the same as at present. But on the other hand, if we find that there are true solar periods and succeed in disentangling them, we may hope to arrive at some measure of predicting power. As I have said, this question is still unsettled, and will of course present itself in different ways to different observers. Meanwhile all we can do is to observe and register the actual state of the sun's surface, and inasmuch as the meteorological occurrences of greatest practical issue do not precede but follow solar phenomena by several months or more, we may thus arrive at a limited amount of practical prevision.

I do not however feel sure that the method of doing this which Mr. Chambers has indicated is in reality the best, for I should imagine that unexceptionable observations of the sun's intrinsic heat-giving power, if these could be obtained, would furnish a more trustworthy instrument of prevision than the sun-spot record.

Then with regard to indirect observations. No doubt those of the barometer are very immediately connected with the occurrences which we wish to foresee, but yet I think it possible that well-selected magnetic observations might ultimately be found to follow more quickly upon solar changes as well as to indicate with a less amount of local influence the true state of the sun.

These however are points that can only be settled by future research. Meanwhile it is extremely gratifying to all who take an interest in this subject to reflect that it is engrossing the attention of observers in all parts of the world.

BALFOUR STEWART

LIFE OF LIVINGSTONE

The Personal Life of David Livingstone, LL.D., D.C.L. Chiefly from his Unpublished Journals and Correspondence in the Possession of his Family. By William Garden Blaikie, D.D., LL.D., New College, Edinburgh. Portrait and Map. (London: Murray, 1880.)

WHEN the news of Livingstone's sad death on the swampy shore of Lake Bangweolo reached this country, and when his body was brought home by his faithful followers to be honoured as the nation honours its greatest and best; and again on the publication of his "Last Journals," we spoke in some detail of the great work he accomplished, and expressed our opinion as to the position which that work had earned for him. The years that have elapsed since Livingstone died at his post have only confirmed the judgment of the nation; and now that Dr. Blaikie's admirably-compiled "Personal

Life" enables us to fill up the portrait, it will be seen that the man was as great as his work. Necessarily the missionary and religious side of Livingstone's character and work occupies a large place in this volume; this was to be expected from a writer who is a prominent leader in the Free Church of Scotland. But we do not think there is any excess in this direction; these were genuine and ever-present aspects of the character of the man, and Dr. Blaikie does not give them place at the expense of any other feature. He has honestly endeavoured to give us a complete portrait of his hero, and in this we think he has decidedly succeeded. Simplicity and transparency were marked features in Livingstone's character from first to last; delight in simple joys, a boyish love of fun, tenderness of heart and all-embracing charity, strong natural affection, the yearnings of which he could and did sacrifice to his still stronger sense of duty, the whole dominated by an all-conquering determination and perseverance in accomplishing the work which he believed was "given him to do." This is the impression which Dr. Blaikie's "Personal Life" gives, and in this it only confirms the impression which is conveyed by a study of Livingstone's own narratives.

Dr. Blaikie, however, tells us many things which must be new to most of those who knew Livingstone only through his works. We learn here how well qualified he was for the work which from early years he seems to have set before himself. Livingstone came of a good stock, which, though humble, knew of and had some pride in its ancestry. One ancestor fought at Culloden on the side of Prince Charlie, for on the mother's side he had some Highland blood in his veins. But the impulsive and sad temperament of the Celt was considerably modified by the practical and hopeful features of the Teutonic blood of his father. The latter was a type of the devout, rigidly honest, intelligent, and comparatively well-read, humble Scotchman, while the mother held the love and respect of her son to the end of her life. The family were poor, and all had to work hard; and early in life young Livingstone had to begin to earn his living in a cotton-mill at Blantyre, near Glasgow, where he was born March 19, 1813. With his first wages he bought a copy of Ruddiman's "Latin Rudiments," and thus early, it is evident, his aspirations went beyond the cotton-mill. His hours were long, but while attending to his "jenny," and till late at night, after his day's work was over, he conned his Ruddiman and other books to qualify himself for a University course. His thirst for reading was great, and he devoured all the books that came within his reach. Natural science also had its attractions for him, which he indulged by scouring the country when he had time in search of natural history specimens. Dr. Blaikie tells of Livingstone's "conversion" when he was a young man. This, in his case, means that what was instinctive action became thenceforth settled and conscious purpose. It was doubtless a proud day both for father and son when the former walked with the latter to Glasgow to see him settled in a humble lodging in order that he might attend the classes at Anderson's College. Livingstone never intended to be a clerical missionary; medicine was the subject of his study in Glasgow, and it was as a medical missionary he intended to accomplish the work of his life. It was only to please his friends and the